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ABSTRACT

Statistics courses are often viewed by many college students as impediments to the attainment of a desired degree. It is not uncommon for students to delay taking required statistics courses until just before graduation. Often part of the reason for this is a transferral of a basic anxiety about mathematics to statistics. The objectives of this study were to examine the relationship between student attitudes, self-concept, mathematics background, and academic performance in a statistics course. The sample used in this study was 68 students in a masters degree program in a school of education; 93 percent of the students were female. Methods, instruments used, and procedures are discussed. Results indicated that course performance was not related to attitudes toward statistics, mathematics self-concept mathematics background or attitudes toward tests. Most of the students attributed their success in the course to their instructor. (CW)

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The Relationship Between Attitudes Toward Statistics, Math Self-Concept, Test Anxiety and Graduate Students' Achievement in an Introductory Statistics Course

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The Relationship Between Attitude Toward Statistics, Math Self-Concept, Test Anxiety and Graduate Students' Achievement in an Introductory Statistics Course

Statistics courses are viewed by most college students as an obstacle standing in the way of attaining their desired degree. It is not uncommon to see students who delay taking the statistics courses until just before graduation (Roberts & Bilderbach, 1980). Few are the students who look forward to the research and statistics course sequence. This description applies equally to undergraduate and to graduate students. College professors who teach the research and statistics course are all too familiar with the high level of anxiety exhibited by the students on the first day of the term. As their instructors, we want our students to know research and statistics and to appreciate their usefulness in their professional and everyday lives.

Statistics courses are viewed by most students as high level math courses. Thus, the math anxiety evidenced by many students is transferred to the statistics course. The math background, in turn,

relates to the students' attitude toward statistics (Harvey, Plake & Wise, 1985; Roberts & Saxe, 1982).

Student anxiety was also studied in relation to performance in a statistics course (Harvey et al., 1985). The measures used were the State-Trait Anxiety Inventory, developed by Spielberger and his colleagues (Spielberger, 1980), and the Mathematics Anxiety Rating Scale-Revised (MARS-R) (Plake & Parker, 1982). Harvey et al. found that anxiety is negatively related to achievement, but the nature of the relationship is unclear.

The students' gender and class level (undergraduate vs. graduate) and their relationship with attitudes toward statistics, statistics achievement and math anxiety have also been investigated. Harvey et al. did not find a significant difference between male and female students, or between undergraduate and graduate students; however, Raiszadeh and Ahmadi (1987) found that female students achieved higher grades in introductory statistics course, when compared to male students.

This present study was undertaken in an attempt to further investigate some of the conflicting results obtained in previous studies.

Objectives of the Study

The major objective was to determine the relationship between academic performance in a statistics course and the students' attitude toward statistics, math self-concept and attitudes toward tests.

A secondary objective was to determine what relationships exist between students' attitudes toward statistics, math self-concept and attitudes toward tests.

A third objective was to investigate the relationship between students' mathematics background and attitude toward statistics, math self-concept and attitude toward tests.

Hypotheses

1. Course achievement in statistics will be positively correlated with students' attitudes toward statistics, math self-concept and attitudes toward tests.

2. There will be a significant positive relationship between attitudes toward statistics, math self-concept and attitudes toward tests.

3. Students with a more extensive math background (i.e. those who had previously taken higher level math courses) will have a more positive attitude toward

statistics, higher math self-concept and a more positive attitude toward tests than students with a less extensive math background.

4. Students with a less extensive math background will experience more positive change in attitude toward statistics and math self-concept than students with a more extensive math background.

5. As a result of taking the course, students will perceive themselves as having a more positive attitude toward statistics.

Method

Sample

The sample for this study consisted of 68 students in a master's degree program in a School of Education at a private college located in a suburb of a large city in the midwest. Seven percent of the students were male, and 93% were female. Students ranged in age from 22 to 50 with a mean of 34 years and standard deviation of 8 years. The students were majors in 10 different departments, with students in Reading and Language, Elementary Education and Early Childhood accounting for approximately two-thirds of the students in the sample. Approximately 40% of the sample were not employed in teaching at the time of the study, while the remainder was teaching from prekindergarten

through post high school level.

Slightly over half of the sample had completed either general math, algebra or geometry as their highest level math course, while slightly less than half of the sample had taken either trigonometry or calculus as their highest level math course. Approximately three-fourths of the students in the sample had completed their last math course in high school or as a freshman or sophomore in college from 1 to 30 years ago.

Instruments

Attitudes Toward Statistics (ATS). This instrument was developed by Wise (1985) to measure change in attitudes of students in introductory statistics courses. The ATS has 29 items, divided into two subscales, measuring attitudes toward the statistics course (9 items) and toward the general field of statistics (20 items). Responses are scored on a 5-point Likert scale. Scores on the Course subscale range from 9 to 45; whereas scores on the Field subscale range from 20 to 100. Thus, the scores on the total ATS range from 29 to 145. Wise reports the reliability to be .90 and .92 for the two scales, respectively.

Mathematics Self-Concept Scale (MSC). Developed by Gourgey (1984), the scale includes 27 items which reflect attitudes toward one's mathematical ability. The responses are scored on a 5-point Likert scale. Thus scores on this scale range from 27 to 135. Gourgey reports the reliability as .96.

Test Attitude Inventory (TAI), also called the Test Anxiety Inventory. This inventory for adults, grades 10 and above, was developed by Spielberger. The TAI has 20 items, scored on a 4-point Likert scale. In this study the scoring of items 2 through 20 was reversed. Thus, a higher score on this measure indicates a more positive attitude towards tests (lower test anxiety); whereas, a lower score indicates a more negative attitude toward tests (higher test anxiety). It is reported by Conetta and Tryon (cited in DeVito, 1984) to be the best instrument to assess attitudes towards tests. Various studies have established the internal consistency reliability to be from .92 to .96 (Spielberger, 1980, p. 5).

Follow-up Questionnaire. The open-ended items on the researcher-constructed questionnaire asked students to indicate in what way, if any, their attitude toward statistics changed and if they thought the information they learned in the course would be useful to them. A

third item on the questionnaire asked for additional comments. The questionnaire items were used to assess changes in the students' perceptions.

Procedures

During the Winter, 1989 term, the two researchers who are experienced instructors each taught two sections each of a quantitative research course that is required as part of the master's of education degree program. The three attitudinal measures (the ATS, MSC and TAI) were administered as pretests and posttests. As a measure of course achievement, the combined scores on the midterm and final exam expressed as a percent correct was calculated for each student. About one month after the study had been completed, the follow-up questionnaire was mailed out to a random sample of 24 of the 68 students who participated in the study. Twenty-one students (88%) returned the questionnaire.

Results

Reliability. The pre- and posttest reliability coefficients for the ATS, MSC and TAI ranged from r = .85 to r = .98 with a median of r = .93. (See Table 1.)

Relationship between course achievement and ATS, MSC and TAI. The correlation between course achievement and pre and posttest ATS Field, Course and

Total scores ranged from r = -.04 to r = -.36. (See Table 2.) This finding indicated there was a somewhat negative relationship between attitude toward statistics and course performance.

The correlations between course performance and MSC pre- and posttest scores were r = -.20 and r = -.08, respectively. Similarily the correlations between course performance and TAI pre- and posttest scores were r = .03 and r = .29. All the correlations were fairly low.

Intercorrelations. Table 3 contains the intercorrelations of pre- and posttest scores of the ATS, MSC and TAI. The ATS Total correlated moderately (r = .39 to r = .54) with the MSC. This relationship was due mostly to the substantial correlation between ATS Course and MSC (r = .55 to r = .74). Although the TAI had the lowest overall correlation with the other two measures, there were moderate positive correlations between the TAI and the MSC (r = .37 to r = .55).

Relationship between student's mathematics background and students' attitudes toward statistics and math self-concept. Students with more extensive math background (upper level) had higher pretest and posttest scores on all three attitude measures than students with less extensive math background (lower

level). (See Table 4.) With the exception of the ATS Field pretest, the differences between the two groups were significant, as hypothesized.

Upon examining the change in students' attitudes toward statistics an math self-concept, it was found there were no statistically significant differences between students with a more extensive versus a less extensive math background. (See Table 5.) However, it can be seen by the mean gain scores found in Table 5 that students in both groups experienced significant increase in their attitude toward statistics and math self-concept. A modest gain in attitude toward tests was shown by the students who had taken lower level math courses; there was a slight decrease in the mean gain score.

Follow-up Questionnaire. Nineteen of the 21 respondents (90%) felt that they were better consumers of research and statistics as a result of being enrolled in the course. Fourteen of the 21 respondents (66%) indicated it was the teacher who made their experience in the course a positive one, while 18 of the 21 respondents (86%) said that the course either reinforced or improved their confidence in dealing with statistics and mathematics.

Discussion

Data in this study were collected using three attitudinal measures and one questionnaire. The reliability levels of all three measures were reported as quite high by their developers (r = .90 to r = .96). This study confirmed the high reliability levels.

The study was designed to test five hypotheses. Three of the five were confirmed, while two were not supported by the findings.

Based on the present study's findings, course performance was not related to attitudes toward statistics, math self-concept or attitude toward test. With the exception of the Test Attitude Inventory (TAI), the correlation of course achievement with the posttest scores was much lower than the correlation with the pretest score. The reasons for the negligible to low negative correlations obtained are not clear and require follow-up studies to further probe the question.

Most intercorrelations of the Attitudes Toward Statistics (ATS) scale, the Math Self-Concept (MSC) scale, and the Test Attitude Inventory (TAI) were statistically significant and fairly high. The lowest correlations were with the TAI which seems to be most resistant to change and the least affected by a

positive experience in a statistics course.

As hypothesized, students with more extensive background scored higher on the ATS, MSC and TAI pretests and posttests. These findings are descriptive and may not be interpreted as causal. That is, it may not be concluded that the more extensive math background caused more positive attitudes.

The fourth hypothesis was not supported by the data. Although it was predicted that students with a less extensive math background would experience more positive change in attitude toward statistics and toward math self-concept than students with a more extensive math background, both groups experienced a significant gain in attitudes on the ATS and the MSC. Attitudes toward tests remained quite stable for both groups.

As hypothesized, all students improved their attitudes toward statistics. This finding confirms results from earlier studies done by Roberts and Saxe (1982) and by Wise (1985). Relatively more gain was shown toward the ATS Course subscale, which substantiates the finding reported by Wise (1985).

The data gathered from the follow-up questionnaire further supported the findings from the instruments regarding the improvement of the students attitudes

toward statistics and math self-concept. Students indicated that at the end of the course they were better consumers of research and statistics and that the course either reinforced or improved their confidence in dealing with statistics and mathematics. Additionally, about two-third of the respondents credited their teachers with making the course a positive experience.

Implications

1. Instructors who teach introductory statistics courses should keep in mind that attitude toward statistics and math self-concept are positively related to each other.

2. Instructors should also keep in mind that students who enter introductory statistics courses with a more extensive math background are more likely to have a more positive attitude toward statistics, a higher math self-concept and less test anxiety and perform better on statistics tests.

3. The students' attitudes toward statistics can be improved, given that they perceive the course as a positive experience. A by-product of the improvement in students' attitudes toward statistics was an improvement in the students mathematical self-concept. Thus, instructors in statistics courses should focus not only on the course content, but also on providing a nurturing, supportive learning environment.

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Table 1

Coefficient Alpha Reliabilities of the Attitude Toward Statistics (ATS) and Math Self-Concept (MSC) Scales, and Test Attitude Inventory (TAI)

Measure	Number of Items	Pretest (n = 59)	Posttest (n = 61)
ATS Field	20	.94	.91
ATS Course	9	.93	.85
ATS Total	29	.95	.92
MSC	27	.98	.97
TAI	20	.96	.93

Table 2

Correlation Between Course Achievement and the Attitude Toward Statistics (ATS) and Math Self-Concept (MSC) Scales, and Test Attitude Inventory (TAI) (N = 51)

Measure		Course Achievement
ATS		
Field	Pre	-.22
	Post	-.14
Course	Pre	-.36*
	Post	-.04
Total	Pre	-.31
	Post	-.11
MSC	Pre	-.20
	Post	-.08
TAI	Pre	.03
	Post	.29

*p <.01

Table 3

Intercorrelations Between the Attitude Toward Statistics (ATS) and Mathematics Self-Concept (MSC) and Test Attitude Inventory (TAI) (N = 52)

Measures		ATS Field		ATS Course		ATS Total		MSC		TAI	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
ATS											
Field	Pre	-	.69**	.60**	.37*	.94**	.63**	.31	.28	.23	.15
	Post		-	.49**	.61**	.67*	.95*	.24	.33*	.12	.09
Course	Pre			-	.67**	.84**	.61**	.74**	.65**	.46**	.21
	Post				-	.54**	.83**	.55**	.68**	.43**	.33*
Total	Pre					-	.69**	.54**	.47**	.35*	.19
	Post						-	.39**	.50**	.26	.20*
MSC	Pre							-	.87**	.55**	.37*
	Post								-	.46**	.39*
TAI	Pre										.83**
	Post										-

*p <.01 **p <.001

Table 4

Comparison of Pretest and Posttest Scores on the Attitude Toward Statistics (ATS), and Mathematics Self-Concept (MSC) Scales and Test Attitude Inventory (TAI) for Students with Less Extensive (Lower Level) vs. More Extensive (Upper Level) Math Background

Measure		Lower Level			Upper Level			t
		n	Mean	SD	n	Mean	SD	
ATS Field	Pre	28	67.86	8.44	23	71.26	14.08	-1.02
	Post	28	77.00	7.49	23	82.52	7.50	-2.62**
ATS Course	Pre	31	19.77	6.99	24	25.75	8.55	-2.78**
	Post	31	29.06	4.21	24	33.38	5.18	-3.31**
ATS Total	Pre	24	88.04	12.97	22	97.86	20.42	-1.93
	Post	24	105.38	8.88	22	116.77	11.32	-3.77***
MSC	Pre	30	78.06	22.50	22	98.95	16.06	-3.91***
	Post	30	87.10	18.27	22	105.09	15.82	-3.79***
TAI	Pre	32	60.75	11.93	25	68.76	8.36	-2.98**
	Post	32	63.71	10.24	25	68.44	8.92	-1.86

*p <.05 **p <.01 ***p <.001

Table 5

Comparison of Gain Scores on the Attitude Toward Statistics (ATS), and Mathematics Self-Concept (MSC) Scales and Test Attitude Inventory (TAI) for Students with Less Extensive vs. More Extensive Math Background

Measure	Lower Level			Upper Level			t
	n	Mean Gain	SD	n	Mean Gain	SD	
ATS Field	28	9.14**	6.48	23	11.26**	10.22	-0.86
ATS Course	31	9.29**	5.82	24	7.63**	6.22	1.01
ATS Total	24	17.33**	10.14	22	18.90**	15.13	-0.41
MSC	30	9.03**	11.44	22	6.14**	8.37	1.05
TAI	32	2.96*	6.62	25	-0.32	6.39	1.90

*p <.01 for gain scores within each level

** p <.001 for gain scores within each level